



Traffic Operational & Safety Analysis Report



US 93 DESIGN DISCUSSIONS

Project Committee:

Evarto to Polson, Montana

Montana Department of Transportation

Federal Highway Administration

The Confederated Salish & Kootenai Tribes of the Flathead Nation

Prime Consultant: Skillings-Connolly, Inc. - Consulting Engineers



MDT



FHWA

**TRAFFIC OPERATIONAL AND SAFETY ANALYSIS
OF RECOMMENDED IMPROVEMENTS
FOR THE US 93 CORRIDOR
FROM EVARO TO POLSON, MONTANA**

prepared by

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Preface

A series of design discussions have been conducted between the Montana Department of Transportation (MDT), the Federal Highway Administration (FHWA), and the Confederated Salish and Kootenai Tribes of the Flathead Nation (CSKT) to reach agreement on a lane configuration for improvement of US Route 93 corridor between Evaro and Polson, Montana. These discussions have been facilitated by Skillings-Connolly, Inc. Midwest Research Institute (MRI) has served as a subcontractor to Skillings-Connolly in this effort. MRI has assisted Skillings-Connolly by conducting traffic operational and safety evaluations of lane configurations for the corridor. This report serves as an attachment to the letter of agreement between MDT, FHWA, and CSKT concerning the US 93 corridor.

This report summarizes the lane configuration that has been agreed to by MDT, FHWA, and CSKT. The report presents design volumes and traffic characteristics for the corridor for the years 2000, 2004, and 2024. Finally, the report estimates the expected traffic operational and safety performance of the recommended lane configuration.

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1. LANE CONFIGURATION AND PRELIMINARY INTERSECTION DESIGNS

MDT, FHWA, and CSKT have agreed to a lane configuration for the US 93 corridor between Evaro and Polson, Montana, that incorporates a variety of roadway cross sections including:

- a two-lane undivided cross section with one traffic lane for each direction of travel
- a three-lane undivided cross section with a two-lane passing or climbing lane in one direction of travel and one traffic lane in the other direction of travel
- a four-lane undivided cross section with two travel lanes in each direction of travel separated by a double yellow centerline
- a four-lane divided cross section with a raised or depressed median whose width will vary based on available right-of-way and other design constraints
- a couplet consisting of two two-lane one-way roadways separated by approximately two blocks

Table 1 summarizes the locations within the corridor where each of these cross sections would be provided as agreed by MDT, FHWA, and CSKT. Table 2 summarizes the total length for which each of these cross sections is recommended in the corridor.

Shoulders with a width of 2.4 m (8 ft) will be provided in rural sections of the corridor. Curb-and-gutter sections are anticipated on US 93 within the towns of Arlee, Ravalli, Ronan, and Pablo, and immediately south of the MT Highway 35 intersection at the south edge of Polson. Intersection and driveway realignments would be made and frontage roads provided as specified in the US 93 access control and corridor preservation plan; changes to that plan can be considered through an established exceptions process.

Table 3 summarizes the preliminary intersection configurations for the US 93 corridor; the locations with left- and right-turn lanes shown in Table 3 may be adjusted, as appropriate, in the detailed design process. The table indicates the following for each intersection:

- location (station)
- name of intersecting streets or roads
- intersection type (number and orientation of legs)
- number of through lanes and turn lanes on the US 93 northbound and southbound approaches

Table 1. Recommended Lane Configuration for US 93 Corridor

General location	Stations		Mileposts		Lane configuration	Length	
	From	To	From	To		km	mi
Evandro	109+50	111+50	6.39	6.51	Existing four-lane undivided	0.20	0.12
Evandro	111+50	129+00	6.51	7.60	Four-lane undivided	1.75	1.09
Finley Creek/Frog Creek	129+00	139+00	7.60	8.22	SB passing lane	1.00	0.62
North of Frog Creek to MRL	139+00	160+20	8.22	9.54	NB passing lane	2.12	1.32
Joe's Smoke Ring	160+20	178+00	9.54	10.64	Two-lane undivided	1.77	1.10
Coriakan Rd-Doney Ln	178+00	217+00	10.64	13.07	SB climbing lane	3.91	2.43
Doney Ln-S. Couture Loop	217+00	248+00	13.07	14.99	NB passing lane	3.09	1.92
S. Couture Loop-Agency Rd	248+00	255+90	14.99	15.48	Two-lane undivided	0.79	0.49
Agency Rd-Coombs Ln	255+90	267+20	15.48	16.18	SB passing lane	1.13	0.70
Coombs Ln-Arlee	267+20	287+00	16.18	17.41	Four-lane divided	1.97	1.23
Arlee	287+00	300+00	17.41	18.22	Couplet composed of two separate two-lane undivided one-way roadways ^a	1.30	0.81
Arlee-Jocko River	300+00	308+40	18.22	18.74	Four-lane divided	0.84	0.52
Jocko River	308+40	316+50	18.74	19.24	Two-lane undivided	0.80	0.50
Schall Flats	316+50	340+00	19.24	20.70	SB passing lane	2.35	1.46
Schall Flats	340+00	379+00	20.70	23.12	NB passing lane	3.90	2.42
Schall Flats-Spring Creek	379+00	385+10	23.12	23.50	Two-lane undivided	0.61	0.38
Spring Creek-Valley Creek Rd	385+10	403+20	23.50	24.63	SB passing lane	1.81	1.13
Ravalli Canyon-Ravalli	403+20	449+70	24.63	27.52	Two-lane undivided	4.65	2.89
Ravalli Hill	449+70	472+10	27.52	28.91	NB climbing lane	2.24	1.39
Ravalli Hill	472+10	480+20	28.91	29.41	Overlapping NB and SB climbing lanes	0.81	0.50
Mission Hill	480+20	508+50	29.41	31.17	SB climbing lane	2.83	1.76
Mission Hill-St. Ignatius	508+50	542+40	31.17	33.27	Two-lane undivided	3.38	2.10
Post Creek Tributaries	542+40	566+60	33.27	34.77	NB passing lane	2.41	1.50
Post Creek Tributaries	566+60	572+40	34.77	35.13	Two-lane undivided	0.58	0.36
Post Creek Tributaries	572+40	599+70	35.13	36.83	SB passing lane	2.74	1.70
Red Horn Rd	599+70	603+10	36.83	37.04	Two-lane undivided	0.34	0.21
Ninepipe Area and Ronan	603+10	767+00	37.04	48.24	No specific lane configuration recommended ^b	18.02	11.20
Ronan-Polson	767+00	937+20	48.24	58.81	Four-lane divided ^c	16.91	10.57

^a This recommended couplet through Arlee will be reviewed in an environmental reevaluation to be prepared.

^b No final lane configuration has been recommended for this portion of the roadway in the Ninepipe area and Ronan. It is recommended that a supplemental EIS be prepared to assess alternative alignments in this area. This area includes the station equation 768+38 Back = 751+93 Ahead.

^c May include a four-lane undivided cross section or a five-lane cross section with a center two-way left-turn lane over a length of approximately 1.2 to 1.5 mi immediately south of MT Highway 35.

NOTE: All station locations and mileposts are approximate and may need to be adjusted in the detailed design process.

Table 2. Summary of Roadway Lengths by Lane Configuration

Lane configuration ^a	Total roadway length	
	km	mi
Two-lane undivided	12.92	8.03
NB passing or climbing lane	13.76	8.55
SB passing or climbing lane	15.77	9.80
Overlapping NB and SB passing or climbing lanes	0.80	0.50
Four-lane undivided	1.95	1.21
Four-lane divided ^b	19.82	12.32
Couplet composed of two separate two-lane one-way roadways	1.30	0.81
Total	66.32	41.22

^a This table does not include the portion of the roadway from Station 603+10 to 767+00 where no lane configuration has been recommended.

^b The totals on this line include a portion of the roadway (approximately 1.2 to 1.5 mi in length) immediately south of MT Highway 35 that may be constructed with a four-lane divided cross section or a five-lane cross section with a center two-way left-turn lane.

Table 3. Recommended Intersection Configurations for US 93 Corridor

Station ^a	Milepost ^a	Name of intersecting road or street	Intersection type ^a	Traffic control ^b	Number of approach lanes					
					Northbound			Southbound		
					Thru	LTL	RTL	Thru	LTL	RTL
115+10	6.74	Evaro Rd	T-Right	Stop sign	2	1	0	2	1	0
116+90	6.85	Grooms Rd	T-Left	Stop sign	2	0	0	2	0	0
121+50	7.13	Bear Grass Mountain Rd/Mercer Rd	Four-leg	Stop sign	2	1	0	2	1	0
129+80	7.59	Candlewick Ln	T-Right	Stop sign	1	0	0	2	0	0
156+40	9.30	Whispering Pines Rd	T-Left	Stop sign	2	1	0	1	0	1
177+40	10.61	Coriacan Rd (relocated)	T-Right	Stop sign	1	0	0	1	1	0
189+50	11.36	East and West Pine Rd	Four-leg	Stop sign	1	1	0	2	1	0
198+70	11.93	Schley Creek Rd	T-Right	Stop sign	1	0	0	2	1	0
217+10	13.07	McClure Rd	Four-leg	Stop sign	2	1	0	1	1	0
233+30	14.08	Mountain Home Ln	T-Right	Stop sign	2	0	0	1	1	0
249+50	15.08	South Couture Loop	T-Left	Stop sign	1	1	0	1	0	1
254+30 ^c	15.38	Agency Rd (Dirty Corner)	T-Right	Stop sign	1	0	0	1	1	0
267+20	16.18	Coombs Ln	T-Left	Stop sign	2	1	0	2	0	0
272+00	16.48	Cottonwood Rd	T-Left	Stop sign	2	1	0	2	0	0
275+00	16.66	Jocko Rd	T-Right	Stop sign	2	0	0	2	1	0
282+10	17.11	Lumpry Rd	T-Left	Stop sign	2	1	0	2	0	0
288+50 ^d	17.50	Powwow Rd/North Couture Loop	Four-leg	Stop sign	2	0	0	2	1	0
290+40 ^d	17.62	Morin St/Bouch St	Four-leg	Stop sign	2	0	0	—	—	—
291+60 ^d	17.70	Wessinger St/Houle St	Four-leg	Stop sign	2	0	0	—	—	—
292+70 ^d	17.76	Taelman St	Four-leg	Stop sign	2	0	0	—	—	—
293+90 ^d	17.84	Whitworth St/Morigean St	Four-leg	Stop sign	2	0	0	—	—	—
298+50 ^d	18.12	Finley Creek Rd/Oxford Ln	Four-leg	Stop sign	2	1	0	2	0	0
303+20	18.42	North St	T-Right	Stop sign	2	0	0	2	0	0
307+60	18.69	Saddle Mountain Rd	T-Left	Stop sign	2	1	0	2	0	0
312+70	19.01	Dumontier Rd	T-Right	Stop sign	1	0	0	1	1	0
325+10	19.78	Detwiler Rd/While Coyote Rd	Four-leg	Stop sign	1	1	0	2	1	0
349+20	21.27	Renfro Rd/Lamoose Ln	Four-leg	Stop sign	2	1	0	1	1	0
372+20	22.70	South Valley Creek Rd	T-Left	Stop sign	2	1	0	1	0	0
408+20	24.95	North Valley Creek Rd	T-Left	Stop sign	1	1	0	1	0	0
449+70	27.51	MT Highway 200	T-Left	Stop sign	2	1	0	1	0	1
476+60	29.18	Ravalli Hill Visitor's Center	Interchange	—	2	—	—	2	—	—
496+90	30.44	Old Freight Rd	T-Left	Stop sign	1	1	1	2	0	0
498+80	30.56	Pistol Creek Rd	T-Right	Stop sign	1	0	0	2	1	0
508+60	31.17	Old US 93	T-Right	Stop sign	1	0	1	2	1	0
514+60	31.56	Blood Ranch Ln	T-Left	Stop sign	1	1	0	1	0	0

Table 3. Recommended Intersection Configurations for US 93 Corridor (Continued)

Station ^a	Milepost ^a	Name of intersecting road or street	Intersection type ^a	Traffic control ^b	Number of approach lanes					
					Northbound			Southbound		
					Thru	LTL	RTL	Thru	LTL	RTL
526+30	32.27	Sabine Rd/Mission Dr	Four-leg	Stop sign	1	1	0	1	1	0
532+40	32.65	Mountain View Dr	T-Right	Signal	1	1	1	1	1	0
538+60 ^c	33.03	Lower Crossing Rd/Airport Rd	Four-leg	Stop sign	1	1	0	1	1	0
570+90	35.04	Pinsonneault Rd/Lemery Ln	Four-leg	Stop sign	1	1	0	1	1	0
587+00	36.04	Hawkins Rd/Ashley Lake Rd	Four-leg	Stop sign	1	1	0	2	1	0
603+10	37.04	Dublin Gulch Rd/Red Horn Rd	Four-leg	Stop sign	1	1	1	1	1	1
–	–	(No recommended configuration for intersections between Stations 603+10 and 767+00)								
768+10	48.31	Baptiste Rd/Spring Creek Rd	Four-leg	Stop sign	2	1	0	2	1	0
796+50	50.07	Mud Creek Ln	Four-leg	Stop sign	2	1	0	2	1	0
808+20	50.80	Old US 93	Four-leg	Stop sign	2	1	1	2	1	1
824+70	51.82	Division St	T-Left	Signal	2	1	1	2	0	1
826+40	51.93	College Rd	T-Right	Stop sign	2	0	0	2	1	0
832+60	52.31	Pablo West Rd/Clairmont Rd	Four-leg	Signal	2	1	1	2	1	1
835+80	52.51	Carlyle Ln	T-Right	Stop sign	2	0	0	2	1	0
840+40	52.80	Northwood Rd	T-Right	Stop sign	2	0	0	2	1	0
846+50	53.17	Old US 93	T-Left	Stop sign	2	1	0	2	0	0
848+80	53.32	Light Rd/Courville Trail	Four-leg	Signal	2	1	1	2	1	1
864+80	54.31	Glover Rd/Mud Lake Trail	Four-leg	Stop sign	2	1	1	2	1	0
880+90	55.31	North Reservoir Rd/Minesinger Trail	Four-leg	Signal	2	1	1	2	1	1
897+00	56.31	Caffrey Rd/Ford Rd	Four-leg	Stop sign	2	1	0	2	1	1
898+80	56.42	Schaeffer Rd	T-Left	Stop sign	2	1	0	2	1	0
906+30	56.89	South Hills Dr	Four-leg	Stop sign	2	1	1	2	1	1
918+70	57.66	Glory Rd	T-Right	Stop sign	2	0	0	2	1	0
924+20	58.00	Clearview Dr	T-Right	Stop sign	2	0	0	2	1	0
937+20	58.81	MT Highway 35	T-Right	Signal	2	0	1	2	1	0

^a Incorporates changes in intersection configuration included in the access control and corridor preservation plan.

^b Stop sign = stop-sign control on minor-road approach(es); signal = traffic signal control anticipated before the design year.

^c Intersection may be relocated.

^d The Arlee couplet would include turnarounds at either end of the town. A turnaround in the vicinity of Finley Creek Rd/Oxford Ln would allow northbound motorists to return south. A turnaround in the vicinity of Powwow Rd/North Couture Loop would allow southbound motorists to return north. One street in Arlee (location still to be determined) would provide access to both the northbound and southbound roadways.

- expected traffic control in the design year (where the need for traffic signal control is indicated, the signals would be installed when warranted, not necessarily as part of the initial construction of the project)

In addition to the intersections shown in Table 3, left- and/or right-turn lanes would also be provided at selected high-volume driveways.

While the lane configuration and the preliminary intersection designs for the corridor shown in Tables 1 and 3 have been agreed to by MDT, FHWA, and CSKT, there may be further modifications based on planned discussions between MDT, FHWA, CSKT, and the county and city agencies responsible for public roads that intersect US 93.

2. DESIGN VOLUMES AND TRAFFIC CHARACTERISTICS

The traffic operational and safety analyses of the US 93 corridor that served as the basis for evaluating the lane configuration and preliminary intersection designs were based on projected design volumes for specific segments of the corridor. The following discussion documents the development of these design volumes.

Rural Portions of the US 93 Corridor

Design volumes for rural portions of the US 93 corridor were developed as described below. For development of design volumes, the rural portion of the corridor was divided into seven analysis segments:

- end of existing four-lane highway at Evaro to south edge of Arlee
- north edge of Arlee to south edge of Ravalli
- north edge of Ravalli (just north of intersection with MT Highway 200) to south edge of St. Ignatius (near old US 93 intersection)
- north edge of St. Ignatius (just north of Lower Crossing/Airport Road) to just south of MT Highway 212
- just north of MT Highway 212 to south edge of Ronan
- north edge of Ronan to south edge of Pablo
- north edge of Pablo to just south of MT Highway 35

Design volumes within the communities of Arlee, Ravalli, St. Ignatius, Ronan, and Pablo are addressed later in this section.

Design Volumes

Each of these alternatives identified above was evaluated for projected traffic volume levels for three years: 2000, 2004, and 2024. The design volumes were based on data from three sources:

- Traffic counts during normal weekday periods made during April and May 2000
- Traffic counts during summer weekend periods made during July and August 2000
- Historical traffic counts from the permanent traffic counter on US 93 just south of Ravalli, including hour-by-hour data for all hours with volumes over 500 veh/h during 1999 and summary data for previous years

Table 4 summarizes the highest volumes counted in the US 93 corridor during 2000. The highest volumes for normal weekdays occurred during the evening peak hour. In no

case was the morning peak-hour volume higher than the evening peak-hour volume for both directions of travel combined. In most cases, the morning peak-hour volume for each direction of travel was lower than the evening peak-hour volume for that same direction of travel. Thus, design volumes based on the evening peak hour are very appropriate for the corridor.

The summer weekend volumes were counted on the weekends of July 28-30, 2000, and August 4-6, 2000. The peak summer weekend volume always occurred on Friday afternoon. The Sunday afternoon peak was spread over a longer period, resulting in lower peak volumes.

Table 5 shows the peak hour factors (PHFs) for the corridor, which represent the ratio between the peak hour flow rate and the flow rate for the highest 15 min of the peak hour. Thus, the PHF quantifies the variation in flow rates during the peak hour.

Table 6 summarizes volumes for 1999 from the permanent traffic counter at Ravalli. The table shows that the 30th highest hour of the year is equivalent to the 30th highest hour of the summer weekends; in other words, all of the peak volumes of the year occur on summer weekends. The 30th highest hour of the year for normal weekdays (i.e., with summer Fridays, all Saturdays, and all Sundays eliminated) is about 86 percent of the 30th highest hour for summer weekends. Table 5 shows the both actual hourly counts and estimates of the highest 15-min counts, expressed as hourly flow rates, based on the peak hour factors for the Arlee to Ravalli segment shown in Table 5.

The data in Tables 4 and 6 indicate that US 93 is a highly recreational route where the highest volumes occur on summer weekends. As shown below, the vehicle mix also differs between normal weekdays and summer weekends, with low truck volumes and higher recreational vehicle volumes on weekends. Design volumes for recreational routes are often treated differently than for non-recreational routes because the high recreational volumes occur only during certain seasons of the year and consist primarily of leisure travelers. For the US 93 corridor, it was decided that:

- the primary design volume used in determining level of service should be the 30th highest hour for normal weekdays
- the 30th highest hour for the entire year (representing summer weekend conditions) should serve as a secondary design volume for which level of service goals might differ from the normal weekday conditions

Traffic volumes for the year 2000 and projected volumes for the years 2004 and 2024 are shown in Tables 7, 8, and 9, respectively. These tables show the estimated 30th highest hour volume for normal weekdays and, for comparative purposes, the estimated 30th through 200th highest hour volumes for the entire year, including summer weekends.

Table 4. Highest Volumes Counted During 2000

Section	Peak hour volume normal weekday				Peak hour volume summer weekend			
	Month	Time	Volume (veh/h)	%NB/%SB	Month	Time	Volume (veh/h)	%NB/%SB
Evaro to Arlee	April	5:00-6:00 pm	673	54/46	August	Fri 4:45-5:45 pm	976	58/42
Arlee to Ravalli	May	4:15-5:15 pm	601	48/52	July	Fri 4:30-5:30 pm	964	63/37
Ravalli to St. Ignatius	May	4:15-5:15 pm	536	41/59	August	Fri 2:30-3:30 pm	860	56/44
St. Ignatius to Hwy 212	April	4:30-5:30 pm	745	41/59	August	Fri 2:00-3:00 pm	924	50/50
Hwy 212 to Ronan	May	4:30-5:30 pm	800	42/58	July	Fri 4:30-5:30 pm	1156	53/47
Ronan to Pablo	May	4:00-5:00 pm	1157	48/52	August	Fri 4:30-5:30 pm	1423	55/45
Pablo to Polson	May	3:45-4:45 pm	962	63/37	August	Fri 3:45-4:45 pm	1264	58/42

NOTE: Volumes represent both directions of travel combined.

Table 5. Peak Hour Factors for Rural Portions of US 93 Corridor

Section	Normal weekday			Summer weekend		
	Peak hour volume	Peak 15-min volume	Peak hour factor ^a	Peak hour volume	Peak 15-min volume	Peak hour factor ^a
Evaro to Arlee	652	168	0.969	868	244	0.889
Arlee to Ravalli	577	150	0.960	930	241	0.965
Ravalli to St. Ignatius	519	134	0.968	797	215	0.927
St. Ignatius to Hwy 212	690	186	0.926	878	231	0.950
Hwy 212 to Ronan	774	200	0.968	1095	289	0.947
Ronan to Pablo	1120	289	0.968	1261	356	0.886
Pablo to Polson	962	248	0.968	1182	316	0.935

NOTE: Volumes represent both directions of travel combined.

^a Peak Hour Factor = Peak 15-min Volume * 4/Peak Hour Volume

Table 6. 1999 Traffic Counts From Permanent Traffic Counter on US 93 South of Ravalli

Time period	Traffic volume (veh/h) for highest hours in specified time periods				
	30th highest hour (DHV)	50th highest hour	100th highest hour	200th highest hour	500th highest hour
HOURLY COUNTS					
Entire year	843	803	769	714	638
Summer weekends	843	803	757	—	—
Normal weekdays	722	710	681	—	—
HOURLY COUNTS ADJUSTED FOR PEAK HOUR FACTOR					
Entire year	874	832	797	740	661
Summer weekends	874	832	784	—	—
Normal weekdays	752	740	709	—	—

NOTE: Volumes represent both directions of travel combined.

Table 7. Traffic Volumes in Rural Portions of US 93 Corridor for Year 2000

Section	Traffic volume (veh/h) for 30th highest hour (DHV) based on normal weekday counts	Traffic volume (veh/h) for entire year including summer weekend counts				
		30th highest hour (DHV)	50th highest hour	100th highest hour	200th highest hour	500th highest hour
Evaro to Arlee	890	930	890	860	790	710
Arlee to Ravalli	750	880	840	810	750	670
Ravalli to St. Ignatius	720	820	780	750	700	620
St. Ignatius to Hwy 212	860	880	840	810	750	670
Hwy 212 to Ronan	970	1050	1000	970	890	800
Ronan to Pablo	1190	1350	1290	1240	1150	1030
Pablo to Polson	1070	1200	1150	1100	1020	910

NOTE: Volumes represent both directions of travel combined.

Table 8. Projected Traffic Volumes in US 93 Corridor for Year 2004

Section	Traffic volume (veh/h) for 30th highest hour (DHV) based on normal weekday counts	Traffic volume (veh/h) for entire year including summer weekend counts				
		30th highest hour (DHV)	50th highest hour	100th highest hour	200th highest hour	500th highest hour
Evaro to Arlee	990	1040	990	960	880	790
Arlee to Ravalli	840	980	940	900	840	750
Ravalli to St. Ignatius	800	920	870	840	780	690
St. Ignatius to Hwy 212	960	980	940	900	840	750
Hwy 212 to Ronan	1080	1170	1120	1080	990	890
Ronan to Pablo	1330	1510	1440	1380	1280	1150
Pablo to Polson	1190	1340	1280	1230	1140	1020

NOTE: Volumes represent both directions of travel combined.

Table 9. Projected Traffic Volumes for Rural Portions of US 93 Corridor for Year 2024

Section	Traffic volume (veh/h) for 30th highest hour (DHV) based on normal weekday counts	Traffic volume (veh/h) for entire year including summer weekend counts				
		30th highest hour (DHV)	50th highest hour	100th highest hour	200th highest hour	500th highest hour
Evaro to Arlee	1730	1800	1730	1670	1530	1380
Arlee to Ravalli	1460	1710	1630	1570	1460	1300
Ravalli to St. Ignatius	1400	1590	1510	1460	1360	1200
St. Ignatius to Hwy 212	1670	1710	1630	1570	1460	1300
Hwy 212 to Ronan	1880	2040	1940	1880	1730	1550
Ronan to Pablo	2310	2620	2500	2410	2230	2000
Pablo to Polson	2080	2330	2230	2130	1980	1770

NOTE: Volumes represent both directions of travel combined.

These volumes were based on the counts made during 2000 in the April/May and July/August periods, with appropriate adjustments based on data from the permanent counter at Ravalli to represent specific hours of the year. The tabulated data show that the 30th highest hour for normal weekdays represents approximately the 50th to 200th highest hour of the entire year, depending upon the analysis section chosen. The traffic volumes for 2004 and 2024 have been projected from the volume levels for the year 2000 using a traffic volume growth rate of 2.8 percent per year. This growth rate has been agreed to by MDT, FHWA, and CSKT as a reasonable expectation for the corridor. The directional split during the peak hour for normal weekdays and summer weekends would be expected to be equivalent to those shown in Table 4.

Table 10 presents comparable average daily traffic volume (ADT) projections for the corridor.

Traffic Characteristics

Table 11 shows estimated percentages of heavy vehicles (trucks and RVs) in the traffic stream for the rural portions of the US 93 corridor. The heavy vehicle percentages were based on axle classification counts on US 93 during the April/May and July/August periods of the year 2000. Heavy vehicle percentages are often lower during peak travel periods than over the day as a whole. Therefore, heavy vehicle percentages for US 93 were determined for the evening peak hour on each analysis segment. The traffic counters used for the field data collection could not distinguish explicitly between trucks and RVs. Therefore, the total heavy vehicle percentage determined from the field counts was separated into truck and RV percentages using data provided by MDT on the average daily RV volumes on US 93.

Modeling of traffic operations on two-lane highways requires an estimate of the desired speeds of drivers under low-volume free-flow conditions. The estimates for both passenger cars and heavy vehicles were based on speed data collected in the US 93 corridor during 2000. These data are summarized in Table 12.

Summary

Table 13 summarizes the design volumes and traffic characteristics that were used in traffic operational analysis of the US 93 corridor.

**Table 10. Projected Average Daily Traffic Volumes for Rural Portions of
US 93 Corridor**

Section	Average daily traffic volume (veh/day)		
	2000	2004	2024
Evaro to Arlee	8,030	8,970	15,580
Arlee to Ravalli	6,800	7,590	13,190
Ravalli to St. Ignatius	6,440	7,190	12,490
St. Ignatius to Hwy 212	7,550	8,430	14,650
Hwy 212 to Ronan	8,740	9,760	16,960
Ronan to Pablo	12,070	13,480	23,420
Pablo to Polson	10,790	12,050	20,930

NOTE: Volumes represent both directions of travel combined.

**Table 11. Estimated Heavy Vehicle Percentages in Rural Portions of
US 93 Corridor**

Section	Normal weekdav peak hour				Summer weekend peak hour			
	Northbound		Southbound		Northbound		Southbound	
	% Trucks	% RVs	% Trucks	% RVs	% Trucks	% RVs	% Trucks	% RVs
Evaro to Arlee	2.0	1.0	8.0	4.0	2.0	3.0	3.0	4.0
Arlee to Ravalli	5.0	3.0	8.0	4.0	2.0	3.0	3.0	4.0
Ravalli to St. Ignatius	6.0	3.0	10.0	5.0	2.0	3.0	4.0	4.0
St. Ignatius to Hwy 212	5.0	3.0	5.0	2.0	3.0	3.0	2.0	3.0
Hwy 212 to Ronan	5.0	2.0	5.0	3.0	3.0	3.0	2.0	3.0
Ronan to Pablo	4.0	1.0	5.0	2.0	2.0	3.0	2.0	3.0
Pablo to Polson	3.0	1.0	8.0	4.0	2.0	3.0	2.0	3.0

**Table 12. Estimates of Driver Desired Speeds in Rural Portions of
US 93 Corridor**

Section	Northbound				Southbound			
	Desired speed for passenger cars (mph)		Desired speed for heavy vehicles (mph)		Desired speed for passenger cars (mph)		Desired speed for heavy vehicles (mph)	
	Mean	Std dev	Mean	Std dev	Mean	Std dev	Mean	Std dev
Evaro to Arlee	66	6.1	63	5.6	66	6.1	63	5.6
Arlee to Ravalli	68	5.5	65	5.0	68	5.5	65	5.0
Ravalli to St. Ignatius	66	5.5	63	5.0	66	5.5	63	5.0
St. Ignatius to Hwy 212	65	5.4	62	4.9	65	5.4	62	4.9
Hwy 212 to Ronan	66	4.8	63	4.3	66	4.8	63	4.3
Ronan to Pablo	66	5.2	63	4.7	66	5.2	63	4.7
Pablo to Polson	66	5.8	63	5.3	66	5.8	63	5.3

Table 13. Summary of Design Volumes and Traffic Characteristics for Rural Portions of US 93 Corridor

Section	Northbound									Southbound								
						Desired speed (mph)									Desired speed (mph)			
						Passenger cars		Heavy vehicles							Passenger cars		Heavy vehicles	
	Volume (veh/h)			% Trucks	% RVs	Mean	Std Dev	Mean	Std Dev	Volume (veh/h)			% Trucks	% RVs	Mean	Std Dev	Mean	Std Dev
2000	2004	2024	2000							2004	2024							
Normal Weekday																		
Evaro to Arlee	480	530	930	2.0	1.0	66	6.1	63	5.6	410	460	800	8.0	4.0	66	6.1	63	5.6
Arlee to Ravalli	360	400	700	5.0	3.0	68	5.5	65	5.0	390	440	760	8.0	4.0	68	5.5	65	5.0
Ravalli to St. Ignatius	300	330	570	6.0	3.0	66	5.5	63	5.0	420	470	830	10.0	5.0	66	5.5	63	5.0
St. Ignatius to Hwy 212	350	390	680	5.0	3.0	65	5.4	62	4.9	510	570	990	5.0	2.0	65	5.4	62	4.9
Hwy 212 to Ronan	410	450	790	5.0	2.0	66	4.8	63	4.3	560	630	1090	5.0	3.0	66	4.8	63	4.3
Ronan to Pablo	570	630	1110	4.0	1.0	66	5.2	63	4.7	620	690	1200	5.0	2.0	66	5.2	63	4.7
Pablo to Polson	670	750	1310	3.0	1.0	66	5.8	63	5.3	400	440	730	8.0	4.0	66	5.8	63	5.3
Summer Weekend																		
Evaro to Arlee	540	600	1040	2.0	3.0	66	6.1	63	5.6	390	440	760	3.0	4.0	66	6.1	63	5.6
Arlee to Ravalli	550	620	1080	2.0	3.0	68	5.5	65	5.0	330	360	630	3.0	4.0	68	5.5	65	5.0
Ravalli to St. Ignatius	460	520	890	2.0	3.0	66	5.5	63	5.0	360	400	700	4.0	3.0	66	5.5	63	5.0
St. Ignatius to Hwy 212	440	490	850	3.0	3.0	65	5.4	62	4.9	440	490	860	2.0	3.0	65	5.4	62	4.9
Hwy 212 to Ronan	560	620	1080	3.0	3.0	66	4.8	63	4.3	490	550	960	2.0	3.0	66	4.8	63	4.3
Ronan to Pablo	740	830	1440	2.0	3.0	66	5.2	63	4.7	610	680	1180	2.0	3.0	66	5.2	63	4.7
Pablo to Polson	700	780	1350	2.0	3.0	66	5.8	63	5.3	500	560	980	2.0	3.0	66	5.8	63	5.3

Cities and Towns in the US 93 Corridor

Design volumes for the cities and towns in the US 93 corridor were developed using turning movement counts made in the field during June 2000. Morning and evening peak period counts were conducted. However, only the evening peak period counts were used to develop the design volumes because, at every count location, the volumes counted in the evening peak period were higher. The turning volumes counted during the evening peak period at each intersection were adjusted by a factor so that they would correspond to the 30th highest hour of the year for normal weekday periods, which was generally equal to approximately the 200th highest hour for the entire year (including summer weekend periods). The adjustment factor used in determining the design volumes for the year 2000 was derived from data for the month of June 1999, and data for the 200th highest hour of 1999 from the permanent traffic counter on US 93 just south of Ravalli. Design volumes for the years 2004 and 2024 were derived using a traffic growth rate of 2.8 percent per year. Table 14 presents the anticipated design volumes for the evening peak hour for the years 2000, 2004, and 2024.

Table 14. Design Volumes and Turning Movement Percentages for Intersections in Cities and Towns in the US 93 Corridor

Intersection	US 93 northbound					US 93 southbound					Side street eastbound					Side street westbound				
	Design volume ^a			% LT	% RT	Design volume ^a			% LT	% RT	Design volume ^a			% LT	% RT	Design volume ^a			% LT	% RT
	(veh/h)					(veh/h)					(veh/h)					(veh/h)				
	2000	2004	2024			2000	2004	2024			2000	2004	2024			2000	2004	2024		
Arlee																				
Couture Loop/ Powwow Rd	500	560	970	0.9	1.1	510	570	990	1.1	2.1	10	20	30	53.8	38.5	10	10	20	10.0	80.0
Morin St/Bouch St	520	590	1020	0.2	0.4	520	580	1010	0.4	0.2	5	5	5	40.0	40.0	10	10	10	50.0	50.0
Wessinger St/ Houle St	530	600	1030	4.3	0.8	520	580	1010	1.5	5.3	40	50	80	27.0	59.5	10	20	30	38.5	46.2
Taelman St	510	570	1000	4.3	1.3	510	570	990	1.7	1.3	20	20	40	44.4	55.6	20	20	30	35.7	57.1
Whitworth St/ Morigean St	520	580	1000	5.9	0.0	490	550	950	1.1	2.9	60	70	120	38.6	56.1	10	10	10	44.4	22.2
Finley Creek Rd/ Oxford Ln	380	420	730	1.7	4.3	410	450	790	1.1	1.1	5	5	5	60.0	40.0	20	20	30	86.7	13.3
Ravalli																				
MT Highway 200	360	400	690	25.5	–	370	410	720	–	5.9	60	20	90	28.6	71.4	–	–	–	–	–
St. Ignatius																				
Sabine Rd/ Mission Dr	280	310	530	0.0	5.7	360	410	710	14.4	0.6	5	5	5	33.3	0.0	60	70	120	31.6	68.4
Mountain View Dr	330	370	640	1.0	13.2	310	350	610	11.1	5.0	30	30	60	29.6	7.4	110	130	220	50.0	25.0
Lower Crossing Rd/ Airport Rd	300	330	580	1.5	5.2	460	510	880	27.2	0.0	10	10	20	0.0	100.0	80	90	150	14.1	84.5
Ronan																				
Garfield St	810	900	1570	–	1.1	790	890	1540	1.5	–	–	–	–	–	–	20	20	30	20.0	80.0
Franklin St	660	740	1280	–	5.1	540	610	1060	4.6	–	–	–	–	–	–	80	90	160	56.8	43.2
Eisenhower St	780	870	1520	6.4	1.3	920	1030	1780	5.9	4.9	60	70	140	10.9	81.3	50	60	100	17.8	77.8
Dayton St	770	860	1490	2.4	–	790	880	1530	–	3.9	40	50	90	30.0	70.0	–	–	–	–	–
Cleveland St	730	810	1410	0.6	0.4	780	870	1510	1.4	0.6	5	5	5	50.0	50.0	20	20	30	37.5	62.5
Buchanan St	740	820	1430	1.6	0.1	770	860	1500	2.4	1.3	30	30	50	16.7	70.8	30	30	80	52.2	39.1
Adams St	750	840	1460	1.6	0.9	880	980	1700	3.5	0.4	0	0	0	0.0	0.0	40	40	70	8.8	91.2
Main St	870	970	1680	19.1	0.9	840	930	1600	1.8	9.5	180	210	360	14.3	83.9	10	10	20	0.0	90.9
Round Butte Rd/ Terrace Lake Rd	540	610	1050	14.1	13.5	700	780	1360	7.9	8.1	330	370	650	39.9	33.0	200	220	390	38.8	27.3
Third Ave NW	630	700	1220	0.3	–	730	820	1430	–	13.9	50	60	100	81.3	18.8	–	–	–	–	–
Old Highway 93	670	750	1300	–	8.1	640	710	1240	0.2	–	–	–	–	–	–	40	50	80	100.0	0.0

**Table 14. Design Volumes and Turning Movement Percentages for Intersections in Cities and Towns
in the US 93 Corridor (Continued)**

Intersection	US 93 northbound					US 93 southbound					Side street eastbound					Side street westbound					
	Design volume ^a			% LT	% RT	Design volume ^a			% LT	% RT	Design volume ^a			% LT	% RT	Design volume ^a			% LT	% RT	
	(veh/h)					(veh/h)					(veh/h)					(veh/h)					
	2000	2004	2024			2000	2004	2024			2000	2004	2024			2000	2004	2024			
Pablo																					
Division St	690	770	1330	5.9	6.7	670	750	1300	8.3	3.4	130	150	250	27.7	46.2	130	150	260	30.9	41.5	
Pablo West Rd/ Clairmont Rd	710	790	1380	9.7	3.7	600	670	1170	6.3	6.2	120	140	240	40.5	42.3	50	50	90	23.3	48.8	
Northwood Rd	630	700	1220	1.6	0.9	540	600	1040	1.2	0.8	30	30	60	19.2	69.2	20	20	30	26.7	20.0	
Old Highway 93 (North)	570	640	1110	1.1	–	610	680	1180	0.0	11.5	60	70	110	75.9	24.1	–	–	–	–	–	
Light Rd/ Courville Trail	650	720	1250	2.4	5.9	570	630	1100	4.4	2.7	30	40	70	38.7	45.2	50	50	90	62.8	32.6	
Polson																					
MT Highway 35	690	770	1340	–	27.0	850	950	1650	59.0	–	–	–	–	–	–	740	830	1440	51.4	48.6	

a Hourly volume based on field counts; adjusted for seasonal effects to represent the 30th highest normal week day hour of the year; future traffic growth estimated at 2.8 percent per year.

3. TRAFFIC OPERATIONAL ANALYSIS

This section of the report presents a traffic operational analysis of the recommended lane configuration for the US 93 corridor. The discussion includes the level of service criteria used for the corridor, the analysis approach used, and the results obtained.

Level of Service Criteria

The level of service (LOS) provided by a highway represents the quality of traffic service provided by that highway. Levels of service for specific facility types are defined by the *Highway Capacity Manual* (HCM).^(1,2) Six levels of service are used to characterize the quality of traffic operational service; these levels of service range from LOS A (the best quality of traffic service) to LOS F (the poorest quality of traffic service). The HCM defines each of these levels of service for specific facility types and provides analytical procedures to determine the level of service for any specified traffic volume level on any specific facility type.

The traffic operational analysis for this study has used the HCM procedures for two-lane highways, multilane highways, unsignalized intersections, and signalized intersections. For multilane highways, unsignalized intersections, and signalized intersections, the level-of-service definitions and procedures of the 1997 HCM were used.⁽¹⁾ For two-lane highways, the 1997 procedures were not used because these procedures do not include any quantitative method to evaluate effect of passing lanes on level of service. Instead, the revised level-of-service definition for two-lane highways in Class I (i.e., arterial highways) from the forthcoming 2000 edition of the HCM⁽²⁾ was used together with a computer simulation model of traffic operations on two-lane highways that is discussed below.

Table 15 presents the level of service criteria from the 2000 edition of the HCM⁽²⁾ for two-lane arterial highways. The level of service for a two-lane highway is defined by two parameters:

- *percent time spent following*, which represents the percentage of their total travel time that drivers spend delayed in platoons behind slower vehicles on a section of two-lane highway, and
- *average travel speed*, which represents the average speed of traffic on a section of two-lane highway

Both the percent time spent following and average travel speed criteria shown in the table must be met in order for a two-lane highway to be classified as operating at a given level of service. However, the average travel speeds in the US 93 corridor always exceeded 90 km/h (55 mi/h) under the conditions analyzed, so the level of service in two-lane highway portions of the corridor is essentially a function of just the percent time spent following criteria shown in the table.

Table 15. Level of Service Criteria for Two-Lane Arterial Highways

Level of service	Percent time spent following	Average travel speed (km/h)
A	≤ 35	> 90
B	≤ 50	> 80
C	≤ 65	> 70
D	≤ 80	> 60
E	> 80	< 60
F	D > C	D > C

NOTE: To achieve any specific level of service, both the percent time spent following and average travel speed criteria must be met.

Design Levels of Service

MDT policy for the design level of service for highway improvement projects in arterial highway corridors like the US 93 corridor is to achieve LOS B in the rural areas of the corridor and LOS C in urban areas of the corridor for a period from the opening of the project to traffic to the design year. This MDT policy is based on Table II-6 of the *AASHTO Policy on Geometric Design of Highways and Streets*, commonly known as the Green Book.⁽³⁾ In applying this policy, the level of service is normally based on the peak 15-min volume within the 30th highest hour of the design year. For the US 93 corridor, the earliest date that any portion of the project might be opened to traffic is 2004 and the design year is 20 years later, or 2024.

For the US 93 corridor from Evaro to Polson, MDT, in consultation with FHWA and CSKT, has decided to approve an exception to their normal policy concerning design level of service for rural areas of the corridor, as stated above. For this project, MDT has sought a design level of service for rural portions of the project as follows:

- for normal weekday traffic, at least LOS B through the first half and at least LOS C through the second half of the 20-year design period, with no portion of the design period closely approaching LOS D
- for summer weekend traffic, at least LOS C through the entire 20-year design period

MDT and FHWA have agreed to the exception to their normal design level of service policy, as described above, for the following reasons:

- Given the highly recreational nature of the US 93 corridor, it was appropriate to give consideration to the normal weekday volumes, as well as summer weekend volumes. The conventional practice of basing design on the 30th highest hour of the year would, in this corridor, result in a design that was based exclusively on peak summer weekend demands which exist on a few days only during the summer season. The approach adopted gives consideration to both normal weekdays and summer weekends, with less restrictive level of service criteria for the summer weekends.

- The policy exception has enabled development of a lane configuration that is consistent with tribal concerns about providing effective wildlife crossings along US 93 and respecting tribal cultural sites, while still providing a level of service that is nearly as high as that normally sought by MDT, as well as substantial safety benefits. The issues of wildlife crossing and cultural sites are of great concern to CSKT and have been respected by MDT and FHWA, given the unique issues associated with the location of the project on the Flathead Indian Reservation.

For intersections in cities and towns along the corridor, the LOS C was used as the design level of service in accordance with established MDT policy.

Traffic Operational Analysis Approach

The traffic operational analysis was conducted with the following analytical procedures:

- TWOPAS computer simulation model for two-lane highways
- HCM procedures for multilane highways, unsignalized intersections, and signalized intersections

The TWOPAS model was used in preference to the HCM procedures for two-lane highways because the 1997 HCM procedures do not include procedures to account for the effects of passing lanes on two-lane roads and the 2000 HCM procedures, while they include a procedure for isolated passing lanes, do not include a procedure to account for the effects of closely spaced passing lanes in the same direction of travel.^(1,2) The TWOPAS model does have the capability to model the traffic operational effects of passing and climbing lanes on two-lane highways; results obtained from the TWOPAS model are compatible with the HCM because both the 1997 and 2000 HCM procedures were developed from TWOPAS.

TWOPAS Model Overview

TWOPAS is a microscopic computer simulation model of traffic on two-lane highways developed for the Federal Highway Administration (FHWA).⁽⁴⁾ TWOPAS simulates the movement of every vehicle and driver on the roadway and updates the position and speed of every vehicle once per second. Drivers make decisions to speed up, slow down, or pass one another based on the driver's desired speed, the roadway alignment, and the presence and behavior of other traffic on the roadway. TWOPAS simulates a variety of vehicle types whose performance characteristics can be specified including five types of passenger cars, four types of trucks, and four types of recreational vehicles.

TWOPAS includes the capability to simulate two-lane roadway sections with any arrangement of passing and no-passing zones and added passing lanes along the highway.

The comparisons between the existing alignment and cross section in the US 93 corridor and various passing lane alternatives has taken advantage of the TWOPAS capability to make “clone” runs in which exactly the same sequence of vehicles and drivers can be run over different geometric and traffic control alternatives.

TWOPAS provides traffic operational performance measures for each alternative evaluated, including percent time spent following and average travel speed, which are used in the HCM to define level of service. In fact, the percent time spent following measure from TWOPAS was used in the development of the current HCM procedures for two-lane highways, so its use for this application is very appropriate.

TWOPAS simulates traffic on a roadway section, but does not address the operation of turning movements on and off the road at intersections. This limitation makes TWOPAS appropriate for analysis of rural highway sections, where turning volumes are relatively low, but inappropriate for two-lane highway sections in towns, where turning volumes are higher. TWOPAS is, therefore, appropriate for the investigation of passing lanes, which are generally located in rural areas outside of towns.

In addition to two-lane highways and two-lane highways with added passing lanes, TWOPAS can evaluate short sections of roadway with a four-lane cross section, where passing lanes overlap or have been built side-by-side.

Traffic Operational Analysis Results for Rural Portions of the Corridor

Traffic operational analyses were performed for both the existing and recommended lane configurations and for the traffic volumes for the years 2000, 2004, and 2024 for both normal weekday and summer weekend conditions. These results were used to estimate the level of service at intervals of two years throughout the study period.

Table 16 summarizes the limits of the roadway sections in the rural areas of the US 93 corridor that were considered in this analysis. The analysis section limits are shown in terms of US 93 stations and mileposts. The roadway section between Red Horn Road and the south city limit of Ronan is not included because no lane configuration has been adopted for that portion of the corridor.

For the entire corridor from Evaro to Polson, including the towns but excluding the section from Red Horn Road to just north of Ronan, an added lane to provide passing opportunities would be available to northbound traffic for 23.3 mi (or 57% of the total roadway length). An added lane to provide passing opportunities to southbound traffic would be available for 24.6 mi (or 60% of the total roadway length). A northbound motorist would never have to travel more than 4.4 mi, and a southbound motorist would never have to travel more than 4.3 mi, without encountering an added lane for their direction of travel, and in most cases the gaps between added lanes are much less.

Tables 17 and 18 present the results of traffic operational analyses for the existing lane configuration for normal weekday and summer weekend traffic volumes, respectively. Comparable data for the recommended lane configuration are presented in Tables 19 and 20. From the south end of the corridor at Evaro to Red Horn Road, the tabulated results are based on TWOPAS modeling results and use the two-lane highway level of service criteria shown in Table 15. From Ronan to Polson, the levels of service for the existing lane configuration are based on TWOPAS model results, while the levels of service for the recommended lane configuration are based on the HCM traffic operational analysis procedures for multilane highways.

Table 16. Analysis Section Limits and Lengths

Section	Station limits	Milepost limits	Length (mi)
Evaro to Arlee	109+50 to 287+00	6.39 to 17.41	11.02
Arlee to Ravalli	295+10 to 436+00	17.91 to 26.66	8.75
Ravalli to St. Ignatius	451+20 to 512+40	27.61 to 31.41	3.80
St. Ignatius to Hwy 212 ^a	539+50 to 678+50	33.09 to 41.71	8.62
Hwy 212 to Ronan ^b	688+60 to 745+40	42.35 to 45.85	3.50
Ronan to Pablo	761+60 to 822+30	47.90 to 51.67	3.77
Pablo to Polson	852+50 to 927+50	53.55 to 58.20	4.65

^a Only the portion of this section south of Red Horn Road (Station 603+10) was included in the traffic operational and safety analyses of the recommended lane configuration.

^b This section was not included in the traffic operational and safety analysis of the recommended lane configuration.

In Tables 17 through 20, each level of service defined in the HCM has been divided into three sublevels to better illustrate the location of the projected operations within that level of service. For example, LOS C for a two-lane highway is defined to include the range of percent time spent following from 50 to 65 percent. In Tables 17 through 20, the range from 50 to 55 percent has been labeled C+, the range from 55 to 60 percent has been labeled C, and the range from 60 to 65 percent has been labeled C-. While these sublevels do not appear in the HCM, they were found to be useful by MDT, FHWA, and CSKT in interpreting the analysis results.

Tables 19 and 20 show that MDT's level of service goal has been met for all portions of the project except the relatively short (3.95 mi) segment from St. Ignatius to Red Horn Road. A complete assessment of traffic operations on this segment cannot be completed until the alignment and lane configuration for the roadway from Red Horn Road to Ronan is determined. This issue will be addressed in a supplemental EIS that will be prepared for this portion of the corridor.

An assessment of the data on percent time spent following and average travel speed in Tables 19 and 20 show that the overall level of service in the year 2024 for the rural portions of the US 93 corridor as a whole would be LOS B- for normal weekdays and LOS B- for summer weekends. This reflects the combined effect of a level of service

Table 17. Summary of Traffic Operational Analysis Results for Existing Lane Configuration for Normal Weekday Volumes

Segment	Percent time spent following			Average travel speed (mph)			Level of service in specified year												
	2000	2004	2024	2000	2004	2024	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024
Evato to Arlee	67.8	70.9	78.9	56.2	55.6	53.8	D+	D+	D	D	D	D	D	D	D-	D-	D-	D-	D-
Arlee to Ravalli	74.3	75.2	81.3	56.4	56.2	54.7	D	D	D-	D-	D-	D-	D-	D-	D-	D-	E+	E+	E+
Ravalli to St. Ignatius	46.6	49.1	56.1	56.1	56.0	55.0	B-	B-	B-	B-	C+	C+	C+	C+	C+	C+	C+	C	C
St. Ignatius to Red Horn Rd	73.4	74.3	79.7	56.7	56.6	55.7	D	D	D	D	D-	D-	D-	D-	D-	D-	D-	D-	D-
Red Horn Rd to Ronan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ronan to Pablo	72.6	74.0	82.8	57.0	56.7	55.2	D	D	D	D	D-	D-	D-	D-	D-	E+	E+	E+	E+
Pablo to Polson	68.4	70.1	79.4	52.9	52.7	51.1	D+	D+	D	D	D	D	D	D	D-	D-	D-	D-	D-

Table 18. Summary of Traffic Operational Analysis Results for Existing Lane Configuration for Summer Weekend Volumes

Segment	Percent time spent following			Average travel speed (mph)			Level of service in specified year												
	2000	2004	2024	2000	2004	2024	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024
Evato to Arlee	71.0	73.6	81.0	56.0	55.6	53.8	D	D	D	D	D-	D-	D-	D-	D-	D-	D-	E+	E+
Arlee to Ravalli	76.9	77.9	84.7	56.7	56.5	54.8	D-	D-	D-	D-	D-	D-	E+	E+	E+	E+	E+	E+	E+
Ravalli to St. Ignatius	46.6	48.8	57.2	57.1	57.0	55.8	B-	B-	B-	B-	C+	C+	C+	C+	C+	C+	C	C	C
St. Ignatius to Red Horn Rd	74.0	74.4	80.4	56.8	56.8	55.8	D	D	D	D-	D-	D-	D-	D-	D-	D-	D-	D-	E+
Red Horn Rd to Ronan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ronan to Pablo	74.7	76.7	86.5	56.8	56.5	54.6	D	D-	D-	D-	D-	D-	E+	E+	E+	E+	E+	E	E
Pablo to Polson	70.1	72.3	80.9	52.9	52.6	50.9	D	D	D	D	D	D	D-	D-	D-	D-	D-	E+	E+

**Table 19. Summary of Traffic Operational Analysis Results for Recommended Lane Configuration
for Normal Weekday Volumes**

Segment	Percent time spent following			Average travel speed (mph)			Level of service in specified year												
	2000	2004	2024	2000	2004	2024	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024
Evato to Arlee	41.0	45.3	56.3	59.5	58.9	56.9	B	B	B–	B–	B–	B–	B–	C	C+	C+	C+	C	C
Arlee to Ravalli	40.1	41.0	50.2	60.4	60.3	58.8	B	B	B	B	B	B	B	B–	B–	B–	B–	B–	C+
Ravalli to St. Ignatius	35.7	39.2	45.6	57.5	57.2	56.4	B+	B+	B+	B+	B	B	B	B	B	B	B	B	B–
St. Ignatius to Red Horn Rd	48.8	52.6	58.9	59.2	58.6	57.6	B–	C+	C+	C+	C+	C+	C	C	C	C	C	C	C
Red Horn Rd to Ronan	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ronan to Pablo ^a	20.4	23.2	29.7	62.8	62.5	61.9	A	A	A	A	A	A	A	A	A–	A–	A–	A–	A–
Pablo to Polson ^b	20.2	23.3	33.4	58.3	58.0	57.1	A	A	A	A	A	A	A–	A–	A–	A–	A–	A–	A–

^a Density for the years 2000, 2004, and 2024, respectively, is 4.8, 5.3, and 9.4 passenger cars/hour/lane for the northbound direction of travel, and 5.3, 5.9, and 10.3 passenger cars/hour/lane for the southbound direction of travel; the indicated level of service is for the direction of travel with the higher traffic volume (southbound) based on the HCM multilane highway operational analysis procedures.

^b Density for the years 2000, 2004, and 2024, respectively, is 5.7, 6.3, and 11.1 passenger cars/hour/lane for the northbound direction of travel, and 3.5, 3.8, and 6.3 passenger cars/hour/lane for the southbound direction of travel; the indicated level of service is for the direction of travel with the higher traffic volume (northbound) based on the HCM multilane highway operational analysis procedure.

**Table 20. Summary of Traffic Operational Analysis Results for Recommended Lane Configuration
for Summer Weekend Volumes**

Segment	Percent time spent following			Average travel speed (mph)			Level of service in specified year												
	2000	2004	2024	2000	2004	2024	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2024
Evato to Arlee	43.0	47.0	57.4	59.5	58.8	57.0	B	B	B–	B–	B–	C+	C+	C+	C+	C+	C	C	C
Arlee to Ravalli	42.3	43.9	54.1	60.6	60.4	58.8	B	B	B	B	B–	B–	B–	B–	C+	C+	C+	C+	C+
Ravalli to St. Ignatius	37.7	41.2	49.8	58.2	57.9	56.7	B+	B+	B	B	B	B	B	B–	B–	B–	B–	B–	B–
St. Ignatius to Red Horn Rd	49.2	52.6	60.1	59.3	58.8	57.7	B–	C+	C+	C+	C+	C+	C	C	C	C	C	C	C–
Red Horn Rd to Ronan	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ronan to Pablo ^a	21.5	25.1	34.1	62.7	62.4	61.5	A	A	A	A	A–	A–	A–	A–	A–	A–	A–	A–	B+
Pablo to Polson ^b	22.8	26.4	35.2	58.3	57.9	57.0	A	A	A	A	A	A–	A–	A–	A–	A–	A–	A–	A–

^a Density for the years 2000, 2004, and 2024, respectively, is 6.3, 7.0, and 12.2 passenger cars/hour/lane for the northbound direction of travel, and 5.2, 5.8, and 10.0 passenger cars/hour/lane for the southbound direction of travel; the indicated level of service is for the direction of travel with the higher traffic volume (northbound) based on the HCM multilane highway operational analysis procedures.

^b Density for the years 2000, 2004, and 2024, respectively, is 5.9, 6.6, and 11.4 passenger cars/hour/lane for the northbound direction of travel, and 4.2, 4.7, and 8.3 passenger cars/hour/lane for the southbound direction of travel; the indicated level of service is for the direction of travel with the higher traffic volume (northbound) based on the HCM multilane highway operational analysis procedure.

lower than LOS B– from Evaro to Red Horn Road and a level of service substantially higher than LOS B– from Ronan to Polson. This overall level of service represents the quality of traffic operations that would be experienced by a motorist traveling the entire corridor from Evaro to Polson. However, since many motorists travel only shorter sections of the corridor, the segment-by-segment levels of service shown in Tables 19 and 20 provide the quality of service measures of greatest interest.

Traffic Operational Analysis Results for Cities and Towns in the Corridor

The analysis of traffic operations for the cities and towns in the US 93 corridor was conducted using the 1997 HCM procedures for signalized and unsignalized intersections. For analysis purposes, each signalized intersection was treated as isolated and non-coordinated. Signal timings were developed and optimized using SIGNAL 97 or SYNCHRO 3.2. Levels of service and delay estimates were determined with the Highway Capacity Software (HCS) package. The results of the operational analysis of intersections in cities and towns is summarized in Table 21. Intersections in Ronan were not included in the analysis since no lane configuration has been established for these intersections.

Table 21. US 93 Summary of Intersection Level of Service (LOS) and Delay for Cities and Towns

Location	Existing (2000) PM peak period				No Action 2004 PM peak period				No Action 2024 PM peak period				Proposed Improvements	Recommended improvements (2024) PM peak period			
	Delay/LOS ^a				Delay/LOS ^a				Delay/LOS ^a					Delay/LOS ^a			
	US 93 ^b		Side street		US 93 ^b		Side street		US 93 ^b		Side street			US 93 ^b		Side street	
Arlee																	
Couture Loop/Powwow Rd	8.4	A	19.6	C	8.6	A	22.6	C	10.3	B	118.2	F	2-lane one-way couplet	0.0	A	18.5	C
Morin St/Bouch St	8.5	A	18.7	C	8.7	A	21.3	C	10.4	B	73.9	F	2-lane one-way couplet	0.0	A	18.1	C
Wessinger St/Houle St	8.5	A	19.3	C	8.7	A	23.6	C	10.7	B	323.3	F	2-lane one-way couplet	0.0	A	24.2	C
Taelman St	8.5	A	18.3	C	8.7	A	21.4	C	10.6	B	154.6	F	2-lane one-way couplet	0.0	A	23.4	C
Whitworth St/Morigean St	8.5	A	22.1	C	8.7	A	27.1	D	10.5	B	641.7	F	2-lane one-way couplet	0.0	A	21.6	C
Finley Creek Rd/Oxford Lane	8.1	A	17.0	C	8.3	A	19.2	C	9.4	A	62.7	F	2-lane one-way couplet	0.0	A	16.1	C
Ravalli																	
Montana Highway 200	8.3	A	15.5	C	8.3	A	15.7	C	10.3	B	45.1	E	channelization	10.3	B	21.9	C
St. Ignatius																	
Sabine Rd/Mission Drive	7.9	A	14.4	B	8.0	A	17.5	C	8.9	A	40.3	E	2-lane w/auxiliary lanes and channelization	8.9	A	21.0	C
Mountain View Drive	8.0	A	16.9	C	8.1	A	20.1	C	9.1	A	309.6	F	2-lane w/auxiliary lanes and channelization	12.3	B	12.5	B ^d
Lower Crossing Rd/Airport Rd	8.1	A	12.4	B	8.3	A	13.3	B	9.8	A	51.7	F	2-lane w/auxiliary lanes and channelization	9.9	A	25.0	C
Pablo																	
Division St	9.0	A	32.0	D	9.3	A	51.4	F	12.9	B	— ^e		4 lanes w/ signal	8.6	B	9.3	B ^d
Pablo West Rd/Clairmont Rd	9.0	A	97.2	F	9.4	A	259.9	F	12.8	B	— ^e		4 lanes w/ signal	5.4	B	7.4	B ^d
Northwood Rd	8.8	A	25.4	D	9.1	A	31.1	D	11.5	B	332.6	F	connects to frontage road				
Old Highway 93 (North)	8.8	A	24.7	D	9.0	A	31.0	D	11.4	B	63.2	F	4 lanes	11.2	B	24.7	C
Light Rd/Courville Trail	8.9	A	31.5	D	9.2	A	46.0	E	12.1	B	832.8	F	4 lanes w/signal	3.2	A	14.6	B ^d
Pablo to Polson																	
MT Highway 35	26.4	D	24.2	C ^d	40.0	D	42.5	E ^d	205.1	F	123.4	F ^d	rechannelize existing signalized intersection	26.8	D	18.3	C ^d

^a Based on design volumes presented in Table 14. Delay is expressed in veh-sec. Level of service (LOS) based on 1997 HCM procedures for unsignalized intersections, except for cases identified by footnote d that are based on the 1997 HCM procedures for signalized intersections.

^b LOS is based on the worst-case movement on the major road which is typically a left-turn movement from US 93.

^c LOS is based on the worst-case movement on the side street which is typically a left-turn onto US 93.

^d Analysis based on HCM signalized intersection procedures.

^e Intersection would have no capacity for movements from at least one side-street approach.

4. SAFETY ANALYSIS

This section of the report presents a safety analysis of the recommended lane configuration for the US 93 corridor. The discussion includes the recent safety performance of the US 93 corridor, the methodology for making safety estimates of design improvements, and the predicted safety benefits of the recommended lane configuration.

Recent Safety Performance of US 93 Corridor

An analysis of the recent safety performance of the US 93 corridor was conducted using traffic accident history data for the five-year period from 1995 through 1999, inclusive. The results of this analysis, presented below, serve as the baseline for projection of the future safety performance of the US 93 corridor. This safety analysis developed quantitative estimates of safety performance for the rural portion of the corridor between towns. No formal prediction of project effects has been performed for the sections within towns; however, an analysis of existing safety conditions within the towns found a substantial number of accidents of types that are potentially correctable by the recommended intersection improvements.

Overall Accident Frequency and Accident Rate

Table 22 summarizes the overall accident frequency in the rural portions of the US 93 corridor during the five-year study period. The data in the table show that traffic accidents increased by 10 percent between 1995-1997 and 1998-1999. Thus, total accidents have grown faster in recent years (3.9 percent per year growth in accidents) than the recent growth in traffic volumes. The limits of the analysis sections used in Table 22 and subsequent safety tables are those shown in Table 16.

Table 23 presents the accidents rates for the rural portions of the corridor. The table shows that the accident rates in the corridor are lower than the statewide average for National Highway System (NHS) routes, except for the Evaro to Arlee section which is about equal to the statewide average. Although the accident rate in the Ronan to Pablo section is not particularly high, the number of accidents more than doubled in 1999 compared to previous years. This sudden growth in accidents merits particular concern.

Accident Severity Levels

Table 24 summarizes the severity distribution of accidents in the rural portions of the US 93 corridor. The table shows that the corridor experienced 30 fatal accidents and 279 injury accidents during the 5-year study period. The proportion of fatal accidents in the corridor (4.8 percent) is much higher than the statewide average for NHS routes (1.7 percent). The proportion of nonfatal injury accidents in the corridor (44.2 percent) is also greater than the statewide average for comparable roads (37.1 percent). Thus, high accident severity (i.e., high risk of death or injury when an accident occurs) is a major concern in the corridor.

Table 22. Accident Frequency (1995-1999) by Year for Analysis Sections Between Towns

Year	Number (%) of accidents															
	Evaro to Arlee		Arlee to Ravalli		Ravalli to St. Ignatius		St. Ignatius to Hwy 212		Hwy 212 to Ronan		Ronan to Pablo		Pablo to Polson		All sections combined	
1995	43	(20.9)	20	(17.4)	8	(22.2)	27	(23.4)	2	(5.3)	4	(12.5)	18	(20.2)	122	(19.3)
1996	40	(19.4)	26	(22.6)	8	(22.2)	22	(19.1)	6	(15.8)	6	(18.8)	13	(14.6)	121	(19.2)
1997	35	(17.0)	22	(19.1)	9	(25.0)	23	(20.0)	8	(21.1)	5	(15.6)	19	(21.4)	121	(19.2)
1998	50	(24.3)	27	(23.5)	5	(13.9)	18	(15.7)	11	(29.0)	5	(15.6)	17	(19.1)	133	(21.1)
1999	38	(18.5)	20	(17.4)	6	(16.7)	25	(21.7)	11	(29.0)	12	(37.5)	22	(24.7)	134	(21.2)
Total	206		115		36		115		38		32		89		631	

Table 23. Accident Rates (1995-1999) for Analysis Sections Between Towns

Accident measure	Evaro to Arlee	Arlee to Ravalli	Ravalli to St. Ignatius	St. Ignatius to Hwy 212	Hwy 212 to Ronan	Ronan to Pablo	Pablo to Polson	All sections combined	Statewide average
Number of accidents (1995-1999)	206	115	36	115	38	32	89	631	—
Section length (mi)	11.02	8.72	3.80	8.63	3.50	3.77	4.65	48.78	—
ADT (veh/day) (1997)	7820	6590	6270	7350	8510	11750	10500	7260	—
Exposure (million veh-mi)	157.4	105.3	43.5	115.8	54.4	80.9	89.2	646.5	—
Accident rate per million veh-mi	1.31	1.09	.83	0.99	0.70	0.40	1.00	0.98	1.30

Table 24. Accident Frequency (1995-1999) by Severity Level for Analysis Sections Between Towns

Severity level	Number (%) of accidents																
	Evaro to Arlee		Arlee to Ravalli		Ravalli to St. Ignatius		St. Ignatius to Hwy 212		Hwy 212 to Ronan		Ronan to Pablo		Pablo to Polson		All sections combined		Statewide average
Fatal	10	(4.8)	6	(5.2)	2	(5.5)	8	(7.0)	2	(5.3)	1	(3.1)	1	(1.1)	30	(4.8)	(1.7)
Injury	80	(38.9)	46	(40.0)	23	(63.9)	53	(46.0)	14	(36.8)	21	(65.6)	42	(47.2)	279	(44.2)	(37.1)
Property damage only	116	(56.3)	63	(54.8)	11	(30.6)	54	(47.0)	22	(57.9)	10	(31.3)	46	(51.7)	322	(51.0)	(60.9)
Total	206		115		36		115		38		32		89		631		

Accident Frequency by Relationship to Junction

Table 25 shows the accident frequencies for the rural portions of the US 93 corridor as a function of relationship to junction. Traffic accidents are classified by relationship to junction into four categories: nonintersection, at intersection, intersection related, and driveway. The table shows that accidents in the corridor are more likely to be at nonintersection locations than on NHS routes statewide (74.2 vs. 70.8 percent).

Accident Frequency by Pavement Surface Condition

Table 26 presents the accident frequencies for rural portions of the US 93 corridor classified by the pavement surface condition at the time of the accident. The table shows that the proportion of accidents under adverse pavement surface conditions (wet or ice and snow) is similar to other NHS routes.

Accident Frequency by Accident Type

Table 27 presents the accident frequencies in rural portions of the US 93 corridor classified by accident type. The following accident types are substantially more prevalent in the corridor than on NHS routes statewide:

- head-on (8.9 vs. 2.0 percent)
- rear-end (35.1 vs. 16.9 percent)
- sideswipe, same direction (12.9 vs. 4.3 percent)

Accident Frequencies on Summer Weekends in Comparison to the Rest of the Year

Table 28 shows the comparison of accident frequencies on summer weekends to accident frequencies during the rest of the year. This comparison found that accidents are more likely on summer weekends than during the rest of the year, but the difference is less than would be expected from the increase in traffic volumes. The only exception to this trend appears to be the rural section between Pablo and Polson which appears to experience an unusually high number of summer weekend accidents. The proportion of fatal accidents is slightly less on summer weekends than during the rest of the year, but the proportion of injury accidents is higher.

Summary of Safety Performance for Existing US 93

The existing highway in the rural portions of the US 93 corridor experiences high accident frequencies, although the accident rates (except in the Evaro to Arlee segment) are

Table 25. Accident Frequency (1995-1999) by Relationship to Junction for Analysis Sections Between Towns

	Number (%) of accidents																
	Evaro to Arlee		Arlee to Ravalli		Ravalli to St. Ignatius		St. Ignatius to Hwy 212		Hwy 212 to Ronan		Ronan to Pablo		Pablo to Polson		All sections combined		Statewide average
Nonintersection	158	(76.7)	97	(84.4)	34	(94.4)	86	(74.8)	21	(55.2)	21	(65.6)	51	(57.3)	468	(74.2)	(70.8)
At intersection	11	(5.3)	10	(8.7)	2	(5.6)	18	(15.6)	6	(15.8)	5	(15.6)	13	(14.6)	65	(10.3)	(12.2)
Intersection related	21	(10.2)	6	(5.2)	0	(0.0)	7	(6.1)	9	(23.7)	5	(15.6)	19	(21.4)	67	(10.6)	(13.5)
Driveway	16	(7.8)	2	(1.7)	0	(0.0)	4	(3.5)	2	(5.3)	1	(3.1)	6	(6.7)	31	(4.9)	(3.5)
Total	206		115		36		115		38		32		89		631		

Table 26. Accident Frequency (1995-1999) by Roadway Surface Condition for Analysis Sections Between Towns

Roadway surface condition	Number (%) of accidents																
	Evaro to Arlee		Arlee to Ravalli		Ravalli to St. Ignatius		St. Ignatius to Hwy 212		Hwy 212 to Ronan		Ronan to Pablo		Pablo to Polson		All sections combined		Statewide average
Dry	126	(61.2)	84	(73.0)	26	(72.2)	88	(76.5)	24	(63.2)	22	(68.8)	63	(70.8)	433	(68.6)	(66.0)
Loose gravel	2	(1.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(3.1)	0	(0.0)	3	(0.4)	(0.3)
Wet	20	(9.7)	13	(11.3)	2	(5.5)	12	(10.4)	8	(21.0)	4	(12.5)	8	(9.0)	67	(10.6)	(9.1)
Snow or slush	19	(9.2)	1	(0.9)	3	(8.3)	5	(4.4)	1	(2.6)	2	(6.3)	6	(6.7)	37	(5.9)	(6.8)
Ice	39	(18.9)	17	(14.8)	5	(14.0)	10	(8.7)	5	(13.2)	3	(9.4)	12	(13.4)	91	(14.4)	(17.2)
Total	206		115		36		115		38		32		89		631		

Table 27. Accident Frequency (1995-1999) by Accident Type for Analysis Sections Between Towns

Accident type	Number (%) of accidents																
	Evarto to Arlee		Arlee to Ravalli		Ravalli to St. Ignatius		St. Ignatius to Hwy 212		Hwy 212 to Ronan		Ronan to Pablo		Pablo to Polson		All sections combined		Statewide average
Head on	13	(10.9)	2	(4.4)	1	(5.9)	6	(9.0)	5	(25.0)	0	(0.0)	4	(0.0)	31	(8.9)	(2.0)
Left turn opposite direction	0	(0.0)	0	(0.0)	1	(5.9)	5	(7.5)	1	(5.0)	1	(8.6)	2	(0.0)	10	(2.9)	(1.9)
Left turn same direction	2	(1.7)	2	(4.4)	0	(0.0)	3	(4.5)	1	(5.0)	0	(1.4)	2	(0.0)	10	(2.9)	(1.4)
Other	27	(22.7)	12	(26.1)	10	(58.8)	15	(22.4)	1	(5.0)	4	(15.7)	9	(0.0)	78	(22.4)	(12.5)
Rear end	40	(33.6)	18	(39.1)	1	(5.9)	20	(29.8)	5	(25.0)	8	(41.4)	30	(0.0)	122	(35.1)	(16.9)
Right angle	15	(12.6)	5	(10.9)	0	(0.0)	7	(10.4)	3	(15.0)	1	(18.6)	7	(0.0)	38	(10.9)	(10.3)
Right turn	1	(0.8)	0	(0.0)	0	(0.0)	0	(0.0)	1	(5.0)	0	(1.4)	1	(0.0)	3	(0.8)	(0.6)
Sideswipe opposite direction	0	(0.0)	0	(0.0)	2	(11.8)	3	(4.5)	2	(10.0)	1	(8.6)	3	(0.0)	11	(3.2)	(2.7)
Sideswipe same direction	21	(17.7)	7	(15.2)	2	(11.8)	8	(11.9)	1	(5.0)	2	(4.3)	4	(0.0)	45	(12.9)	(4.3)
Not stated	87		69		19		48		18		15		27	(0.0)	283		
Total	206		115		36		115		38		32		89		631		

Table 28. Comparison of Accident Frequency on Summer Weekends to the Rest of the Year for Analysis Sections Between Towns

Measure	Summer weekends		Summer weekdays		Rest of year	
Number of days (1995-1999)	145		192		1489	
Number of accidents (1995-1999)	57		63		511	
Number of fatal accidents	3	(5.3)	3	(4.8)	24	(4.7)
Number of injury accidents	30	(52.6)	23	(36.5)	226	(44.2)
Number of property-damage-only accidents	24	(42.1)	37	(58.7)	261	(51.1)
Number of accidents per day	0.393		0.328		0.343	

generally lower than the statewide average for comparable facilities. However, the accidents in the corridor have particularly high severities; in particular, nearly 5 percent of accidents involve fatalities, in comparison to 1.7 percent for comparable facilities. The accident types in the corridor of greatest concern are nonintersection head-on, rear-end, and sideswipe, same-direction collisions. These accident types are generally correctable by design improvements that increase the availability of passing opportunities; such design improvements include passing lanes, climbing lanes, and four-lane sections. Thus, the recommended lane configuration incorporates design improvements that are well suited to address the key traffic accident patterns observed in the corridor.

Methodology for Making Safety Estimates of Design Improvements

Estimates of the effectiveness of several design alternatives in improving safety were made as part of this evaluation. The design alternatives of interest include:

- a two-lane highway with full shoulders
- a two-lane highway with full shoulders and an added passing or climbing lane in one direction of travel
- a two-lane highway with full shoulders and added passing or climbing lanes in both directions of travel (i.e., a short four-lane highway section to provide improved passing opportunities)
- a continuous four-lane divided highway section

The effectiveness of these design alternatives in improving accidents were based on research results and evaluation methodologies developed by Zegeer et al.,⁽⁵⁾ Harwood and St. John,⁽⁶⁾ Harwood and Hoban,⁽⁷⁾ Harwood et al.,⁽⁸⁾ and Council and Stewart.⁽⁹⁾

The starting point of the safety evaluation was the recent safety performance of the existing US 93 alignment and cross section presented above. It was assumed that if no improvements were made in the corridor, traffic accident frequency would increase at the rate of 2.8 percent per year, just as traffic is forecast to grow at 2.8 percent per year. It is possible that traffic accident frequency may increase at a smaller growth rate than traffic volumes, but there are no data available to quantify such an effect.

Estimates of the safety effectiveness of design improvements are based on research results that indicate high site-to-site variability in the results. Thus, the findings about the safety effects of the proposed lane configuration provide average or expected values that, by their nature, are much less precise than the findings about traffic operations and level of service. Despite this lack of precision, the results provide a clear indication that the proposed lane configuration is likely to result in substantial safety benefits.

The safety evaluation assumes that the existing shoulders on the rural portions of the US 93 corridor, which range from 2 to 5 ft in width, would be widened to 8 ft in width.

Wider shoulders would be provided in both the portions of the corridor where a two-lane cross section would remain and in those portions where lanes would be added. As in the case of most geometric improvements, there are varying findings in the literature concerning the safety effects of providing full shoulders on a facility that currently has narrow shoulders. In the recent development of an FHWA accident prediction model for two-lane highways, an expert panel was convened to compare these studies and reach consensus on the safety effects of widening shoulders.⁽⁸⁾ The panel recommended that the finding of a study by Zegeer et al.⁽⁵⁾ be used as the measure of effectiveness for providing full shoulders on a two-lane highway with narrow shoulders and ADT over 2,000 vehicles per day:

Existing shoulder width (ft)	Percentage reduction in “related” accidents from providing full shoulders
2	30%
3	22.5%
4	15%
5	7.5%

The “related” accidents to which the accident modification factors apply are non-intersection single-vehicle run-off-road accidents; multiple-vehicle, opposite-direction collisions; and multiple-vehicle same-direction sideswipe collisions.

Previous research has found that the addition of a passing lane on an existing two-lane highway reduces accidents by 25 percent on the average.^(6,7) Short, undivided four-lane sections to increase passing opportunities on a two-lane highways (i.e., side-by-side passing lanes) have been found to reduce accidents by 35 percent.^(6,7) These percentage reductions apply to the total number of non-intersection accidents within those portions of the roadway where passing lanes or short four-lane sections have been provided. These effectiveness estimates for passing lanes and short four-lane sections have been recommended by the FHWA expert panel mentioned above for use in estimating the safety effectiveness of two-lane highway improvements.⁽⁸⁾

Many of the projects used to establish the estimated 25 percent and 35 percent accident reduction effectiveness for passing lanes and short four-lane sections, respectively, also included provision of full shoulders. Thus, it cannot be assumed that the safety effects of passing lanes and shoulders can simply be combined. It is estimated that, if passing lanes and short four-lane sections are assigned the above effectiveness estimates, then provision of full shoulders within the added lane sections would provide only about half the benefits expected from provision of full shoulders by themselves. The safety effectiveness of this cross sections with added lanes and full shoulders was estimated as follows:

- a 25-percent reduction in total accidents plus half of the effect of full shoulders on related accidents (shown above) within passing or climbing lane sections

- a 35-percent reduction in total accidents plus half of the effect of full shoulders on related accidents (shown above) within short sections of four-lane cross section (e.g., where passing or climbing lanes in opposite directions of travel overlap)
- the effect of full shoulders alone in those areas where added lanes are not provided and a two-lane highway cross section remains

These safety effectiveness estimates were used in determining the anticipated safety performance of the recommended lane configuration for rural portions of the US 93 corridor from Evaro to Red Horn Road.

The final cross section improvement evaluated was the provision of a continuous four-lane divided roadway, which is the recommended lane configuration for the US 93 corridor from Ronan to Polson.

The best comparison between the safety performance of a two-lane undivided roadway and a four-lane divided nonfreeway facility found in the literature was the recent study by Council and Stewart.⁽⁹⁾ Council and Stewart found that non-intersection accidents on a two-lane undivided highway can be predicted as:

$$N_{2U} = 0.536 e^{-3.0188} ADT^{0.9048} e^{-0.2542LW} e^{-0.1043SW} \quad (1)$$

where: N_{2U} = expected number of non-intersection accidents per mile per year on a two-lane undivided highway
 ADT = average daily traffic volume (veh/day)
 LW = lane width on two lane highway (ft)
 SW = shoulder width on two-lane highway (ft)

The comparable model for four-lane divided highway developed by Council and Stewart is:

$$N_{4D} = 0.536 e^{-8.9871} ADT^{1.0707} \quad (2)$$

where: N_{4D} = expected number of non-intersection accidents per mile per year on a four-lane divided highway

Equation (2) does not contain terms for the effect of lane width and shoulder width, but is intended to represent a four-lane divided cross section with 12-ft lanes and full shoulders, comparable to the recommended lane configuration. While Equation (2) does not contain an explicit term to represent the width of the median on the divided highway, the data used by Council and Stewart to develop the model had an average median width of 60 ft, which is comparable to the recommended lane configuration.

The percentage reduction in non-intersection accidents resulting from conversion from a two-lane undivided to a four-lane divided cross section can be estimated as:

$$R_{2U/4D} = \frac{N_{2U} - N_{4D}}{N_{2U}} (100) \quad (3)$$

The addition of left-turn lanes at unsignalized intersections was estimated to reduce intersection-related accidents as follows:

- a 22-percent reduction in total intersection-related accidents for addition of one left-turn lane on a major-road approach to a three-leg intersection
- a 24-percent reduction in total intersection-related accidents for addition of one left-turn lane on a major-road approach to a four-leg intersection
- a 42-percent reduction in total intersection-related accidents for addition of left-turn lanes on both major-road approaches to a four-leg intersection

These estimates for effectiveness of left-turn lane installation were also developed by the FHWA expert panel discussed above.⁽⁸⁾

Safety Analysis Results for Rural Portions of the Corridor

Table 29 presents the estimated safety effects for improving the rural positions of the US 93 corridor from the existing lane configuration to the recommended lane configuration. The table shows the estimated percentage reduction in fatal, nonfatal injury, and property-damage-only (PDO) accidents the total number of accidents of each severity level forecast to be reduced by construction of the recommended lane configuration (in comparison to the existing lane configuration) over the 20-year period from 2004 to 2024. The table shows that the anticipated effects of constructing an improvement include the reduction of 70 fatal accidents, 520 nonfatal injury accidents, and 650 PDO accidents, for a total anticipated reduction of 1,235 accidents over a 20-year period. This is the best available estimate for the safety effectiveness of the proposed lane configuration but, as stated above, substantial variations above or below this estimate are possible.

Safety Analysis Results for Cities and Towns in the Corridor

The safety analysis of US 93 in cities and towns within the US 93 corridor focused on traffic accident frequency and traffic accident patterns at specific intersections. A total of 16 intersections in Arlee, Ravalli, St. Ignatius, Pablo, and Polson were reviewed. These intersections experienced a total of 64 traffic accidents in the five-year period from 1995 to 1999. Table 30 presents the accident frequencies for each intersection by year. Intersections in Ronan were not included in the analysis since no lane configuration has been established for these intersections.

Table 30 shows a general trend towards an increase in traffic accidents at intersections in the cities and towns in the US 93 corridor. There were 10 to 11 accidents per year in 1995-1996 and 14 to 15 accidents per year in 1997-1999 at intersections in cities and towns in the corridor. The table indicates the predominant accident type at each

Table 29. Estimated Safety Effects of Recommended Lane Configuration for Analysis Sections Between Towns

Section	Percent reduction in accident frequency				Number of accidents reduced (2004-2024)			
	Fatal	Injury	PDO	Combined	Fatal	Injury	PDO	Combined
Evaro to Arlee	27	18	21	21	20	90	160	270
Arlee to Ravalli	19	28	31		10	80	120	210
Ravalli to St. Ignatius	8	13	15	14	5	60	110	175
St. Ignatius to Red Horn Rd	32	35	29	32	20	70	60	150
Red Horn Rd to Ronan	–	–	–	–	–	–	–	–
Ronan to Pablo	61	54	57	55	5	70	40	115
Pablo to Polson ^a	66	55	55	54	5	150	160	315
Total					70	520	650	1235

^a This estimate assumes the use of a four-lane divided cross section from Pablo to MT Highway 35. In fact, a four-lane undivided cross section or five-lane with a center two-way left-turn lane may be considered for approximately 1.2 to 1.5 mi immediately south of MT Highway 35. This could result in a small reduction of the safety effectiveness estimates shown above.

Table 30. Accident Frequency (1995-1999) and Potentially Correctable Accident Patterns at Intersections in Cities and Towns in the US 93 Corridor

Intersection	Accident frequency by year						Predominant accident pattern		Proposed improvement	Anticipated positive effect?	
	1995	1996	1997	1998	1999	Total	Type	Accident frequency (1995-1999)		Yes	No
Arlee											
Couture Loop/Powwow Rd	1	0	2	0	1	4	Rear end	2	Couplet	X	
Morin St/Bouch St	0	0	0	0	0	0	None	—	—		
Wessinger St/Houle St	0	0	0	1	0	1	Rear end	1	Couplet	X	
Taelman St	0	0	1	1	0	2	Rear end	1	Couplet	X	
Whitworth St/Morigean St	0	0	0	2	0	2	Rear end	1	Couplet	X	
Finley Creek Rd/Oxford Ln	1	1	0	0	0	2	None	—	—		
Ravalli											
MT Highway 200	0	0	0	2	1	3	Right angle	2	Channelization	X	
St. Ignatius											
Sabine Rd/Mission Dr	0	1	2	1	2	6	Rear end	3	Channelization	X	
Mountain View Dr	0	0	2	3	2	7	Right angle	4	Channelization	X	
Lower Crossing Rd/Airport Rd	1	0	0	1	0	2	None	—	—		
Pablo											
Division St	1	3	2	0	2	8	Right angle	5	Signalization	X	
Pablo West Rd/Clairmont Rd	2	0	1	1	2	6	Right angle	3	Signalization	X	
Northwood Rd	1	2	1	0	0	4	Right angle	3	—		
Old Highway 93 (North)	0	0	0	1	1	2	None	—	—		
Light Rd/Courville Trail	3	3	1	0	1	8	Right angle	3	Signalization	X	
Polson											
MT Highway 35	0	1	2	2	2	7	Rear end	5	Channelization	X	
Total accidents	10	11	14	15	14	64	Potentially correctable accidents	33			

intersection where there was a pattern of accident types that is potentially correctable for improvements to intersection geometrics and traffic control. The accident patterns that were observed included rear-end and right-angle accidents.

A total of 33 of the 64 accidents (52 percent) that occurred at the intersections represent accident patterns that are potentially correctable by intersection improvements. The recommended improvements for the US 93 corridor will have an anticipated positive effect on 30 of those 33 potentially correctable accidents (91 percent). No quantitative estimate has been made of the anticipated percentage reduction in accidents that may result from these intersection improvements.

5. REFERENCES

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